PATENT SPECIFICATION 823,353

DRAWINGS ATTACHED.

Date of Application and filing Complete Specification : Aug. 12, 1957. No. 25418/57.

Application made in United States of America on Sept. 7, 1956.

Complete Specification Published : Nov. 11, 1959.

Index at Acceptance :—**Classes 9(1)**, C(1A1 : 1A2 : 4) ; **and 51(2)**, B7(E2 : X).

International Classification :—**B22b. F07f.**

COMPLETE SPECIFICATION.

Improvements in or relating to the Purging of Electric Furnaces.

We, E.I. Du Pont De Nemours and Company, a Corporation organized and existing under the laws of the State of Delaware, United States of America, of Wilmington 98, Delaware, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement :—

This invention relates to a novel method and device for purging an electric furnace.

Electric furnaces of various types are widely used in the metals industry, both for the preparation of a metal from a compound thereof, usually its oxide, and for the preparation of metal alloys. The furnaces are of varying design, depending upon the type of operation they are to perform. One type used widely in the preparation of ferrous alloys and, more recently, in the preparation of non-ferrous metals, is constructed in the form of a large cylindrical pot having a steel shell lined with refractory bricks at the sides and floored with a carbon-block hearth. The furnace is generally open at the top and has a tapping channel at the bottom extending from the hearth through the steel shell. The tap hole at the shell has a diameter of from 4 to 6 inches and is closed by a carbon plug when no tapping is in progress. Usually three electrodes are suspended in the furnace equidistant from each other and from the floor of the furnace.

In the use of this type of furnace for the reduction of an oxide of a metal to its metallic state, as for example, silicon from silicon dioxide, a mixture of the metal oxide, for example, pebble grade quartzite, and carbonaceous materials, such as coal, coke, wood chips, etc., is charged into the furnace and current is applied to the electrodes. A pool of molten metal forms at the bottom of each electrode, the unmelted material surrounding the molten metal forming a so-called "crucible." The unmolten material in the furnace is in the form of a solid, porous mass which settles slowly as the reaction in the "crucible" proceeds and the oxide of the metal is reduced to the metal itself. The gases produced by the reduction of the oxide pass through the porous mass and are vented from the top of the furnace. When sufficient metal has accumulated in the "crucibles" and tapping channel, the furnace is tapped. Molten metal and slag flow down to the tapping channel from the "crucibles" through the cracks and channels of the porous mass which fills the main volume of the furnace. To maintain continuous production, new material is added intermittently at the top of the furnace, and the tapping operation is repeated as often as sufficient molten metal is produced. Very high temperatures are encountered in this reduction process. In the production of silicon, for example, the molten metal and slag issuing from the tap hole are at a temperature of about 2000° C., while the temperature at the electrodes is estimated to be about 3500° C.

Smooth operation of a furnace of the described type depends to an important degree upon the maintenance of the mass of unmolten material in a porous condition. One condition to which the furnace is subject is that the mass between the electrodes and the tapping channel gradually becomes impervious to fluid flow because of the accumulation of high melting materials, such as the metal carbides. This blockage slows the flow of molten material and hence prolongs the tapping operation. If the flow of material is sufficiently hindered, the liquid

level in the crucible rises, forcing withdrawal of the electrodes to maintain an arc. The retreat of the reaction zone further from the tapping channel is detrimental to continued operation, and ultimately shut-down and expensive removal of the hardened mass are required.

A procedure now used for alleviating this condition is the driving of green pine poles into the furnace through the tap hole. This operation is known within the industry as "purging" the furnace. The heat within the furnace causes a rapid combustion of the poles and the formation of large quantities of gas and vapour which have some effect on re-opening the clogged crevices or producing new crevices for the flow of molten metal. The driving of the pole is a hazardous operation and the procedure produces much smoke and many flying sparks. The improvement produced is only temporary and ultimately no final improvement of furnace efficiency is accomplished by purging in this way. In addition, it is sometimes helpful to drive heavy steel members such as railroad rails into the furnace to break up the solid masses obstructing flow.

An object of this invention is to provide a highly effective method for purging an electric furnace of the type described. A further object is to provide a device for carrying out the method of this invention.

It has been proposed to tap blast furnaces and the like by drilling out the clay plug in the tap hole, inserting into the tap hole (but not into the body of the furnace) an explosive charge formed so that on detonation the energy of the explosion is directed along the axis of the charge, and initiating the charge. By this means a hole is blown in the solid crust round the interior of the wall of the furnace. However, this expedient is not useful for purging electric furnaces.

Nevertheless it has now been found possible, by working under suitable conditions, to employ an explosive charge satisfactorily to purge an electric furnace.

Accordingly, the invention comprises introducing a substantially non-directional detonating explosive charge through the tap hole and into the interior of the furnace and initiating this charge. To prevent the explosive charge from being decomposed or prematurely ignited or detonated by the heat within the furnace, the charge is surrounded by a non-combustible insulating jacket which will provide sufficient insulation to permit insertion of the charge and initiation thereof before the charge can be affected by the heat from the furnace. Thus, the device used to carry out the method of this invention preferably comprises a cylindrical detonating explosive charge within a cylindrical insulating jacket, an initiation means in contact with the explosive charge, and a loading pole attached to the jacket to facilitate introduction of the jacketed charge into the furnace. Preferably, the loading pole will contain a passage for the initiation means, thereby protecting the initiation means from exposure to the furnace heat.

In order to describe the invention more completely, reference is now made to the accompanying drawing in which 1 represents a charge of detonating explosive, for example RDX because of its high thermal stability, 2 represents an insulating jacket, for example a high-strength gypsum-perlite composition containing fibre-glass reinforcement, 3 represents a loading pole, for example a fibreboard tube, 4 represents a central passage longitudinally through the loading pole 3, and 5 represents a length of detonating fuse.

In carrying out the method of the present invention, a conventional electric initiator is connected to the free end of the detonating fuse and the wires are connected to a source of current through a firing switch. The operator then grasps the loading pole and thrusts the jacketed and primed explosive charge into the furnace through the tap hole from which the carbon plug has been removed until the desired positioning of the charge is achieved or the further movement of the assembly is prevented by an obstruction in the tapping channel. The loading pole is then released, and, from a safe distance, the electric initiator is energized by actuation of the firing switch. The initiation of the detonating fuse by the electric initiator is transmitted to the main charge, and its detonation provides the desired purging action. If necessary, the operation can be repeated using fresh assemblies until the channel is cleared.

Alternatively, the detonating fuse may be partially or entirely replaced by the electric initiator in which case the wires would pass through the passage in the loading pole. If needed, a booster charge may be inserted adjacent to the main charge to ensure its initiation from the initiating source.

Experiments were made in which insulating jackets consisting of 50% high strength gypsum and 50% perlite, reinforced with fibre-glass, were thrust into the tap hole and the temperature rise inside the jacket was measured. The jackets all had an outside diameter of 5 inches, the inside diameter depending upon the wall thickness. The jackets before entrance into the tap hole were at about 120° F., the ambient temperature in the vicinity of the furnace. The results were as follows :—

TABLE.

Wall thickness (inches)	1	$1\frac{1}{2}$	$1\frac{3}{4}$
Temp.* after 30 seconds (° F.) ..	120	120	120
Temp. after 45 seconds (° F.) ..	120	200	120
Temp. after 60 seconds (° F.) ..	220	240	120
Temp. after 75 seconds (° F.) ..	600	240	120
Temp. after 90 seconds (° F.) ..	1000	270	200

* Measured inside the insulating jacket.

Further experiments showed that an assembled unit could be introduced into the furnace and initiated within a period of 15 seconds. Thus, a jacket having a wall thickness of at least 1 inch will provide adequate protection to an explosive charge thermally stable at a temperature of 220° F. Preferably, the explosive charge should not change state, i.e. become liquefied, at this temperature, although a composition containing less than a major proportion of a lower melting explosive, for example, an amatol composition, can be used. HMX (CYCLOtetramethylenetetranitramine) and RDX are preferred explosives for the charge because of their excellent thermal stability; however, other high explosives, such as PETN, pentolite, amatols, etc., can be used.

The quantity of explosive required will depend upon the severity of the obstruction and the strength of the explosive composition. In an experiment in which 210 grams of pentolite was used, only slight improvement in the flow from the tap hole resulted, whereas a 1 pound charge of an amatol composition used immediately afterward in the same tap hole did an excellent job of freeing the passages to the tap hole of the furnace.

A typical assembly, accordingly, could consist of an insulating jacket having a length of about 20 inches, an outside diameter of $3\frac{1}{2}$ inches, and an inside diameter of $1\frac{1}{2}$ inches, an explosive charge of about 1 pound of RDX and a loading pole about 15 feet in length having an outside diameter of $2\frac{1}{2}$ inches and a central longitudinal passageway with a $\frac{1}{2}$ inch diameter.

WHAT WE CLAIM IS:—

1. A method for purging an electric furnace of the type described which comprises inserting through the tap hole into the interior of the furnace a substantially non-directional detonating explosive charge within an insulating jacket, and initiating said charge.

2. A method as claimed in Claim 1, wherein said initiation is produced by application of an electric current.

3. A device for purging an electric furnace of the type described which comprises a cylindrical charge of a detonating explosive, a tubular jacket of a non-combustible heat-insulating material enclosing said charge, a means for initiating said explosive charge in contact with said charge, and a loading pole firmly secured to said jacket.

4. A device as claimed in Claim 3, wherein said loading pole contains a passage for the initiation means.

5. A device as claimed in Claim 3 or 4, wherein said initiation means comprises detonating fuse.

6. A device as claimed in Claim 3 or 4, wherein said initiation means comprises an electric initiator.

7. A method as claimed in Claim 1 substantially as hereinbefore described with reference to the accompanying drawing.

8. A device as claimed in Claim 3 substantially as shown in the accompanying drawing.

J. A. KEMP & CO.,
Chartered Patent Agents,
9 Staple Inn, London, W.C.1.

Abingdon: Printed for Her Majesty's Stationery Office, by Burgess & Son (Abingdon), Ltd.—1959.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2,
from which copies may be obtained.

823,353 COMPLETE SPECIFICATION

1 SHEET

This drawing is a reproduction of the Original on a reduced scale.